especially his American friend, Prof. Cleveland Abbe, who aroused my interest in meteorology and called my attention to his great meteorological work. Just a year ago I returned to Japan with great enthusiasm and sweet anticipation of seeing our eminent mathematician and meteorologist and of studying under his personal guidance; but alas! I found him intellectually dead. It is, however, a great privilege and honor to me that I now hold the chair of meteorology at the Naval Staff College which Professor Kitao once occupied and that the task of writing his memoir has fallen to my hand.

It is certainly a great misfortune that both his greatness and his work, like those of my former master, Professor J. Willard Gibbs, were not fully appreciated in the world, and were really very little known to laymen as well as to scientists in Japan. * * *

H. C. RUSSELL.[1]

The announcement of the death of Mr. H. C. Russell, who for nearly forty years was among the foremost representatives of science in the colony of New South Wales, has been received with great regret by many men of science. Since 1870 he held the post of government astronomer and director of the Sydney Observatory, in succession to Mr. G. R. Smalley, and in that capacity rendered most important services to the colony. His first duty on appointment was to organize the resources of the colony for the observation of the transit of Venus. With small funds, little skilled assistance, and short time for preparation he nevertheless succeeded in equipping several stations in a highly efficient manner, reflecting great credit upon the readiness of the colonists and the exertions of the observatory staff.

Thenceforward the observatory pursued a course marked by continually increasing usefulness, culminating in the acceptance of a share in the international photographic chart of the heavens. * * *

But most of all the colony is indebted to him for his organization of the meteorological service. He had charge of a district of the climate of which little was known, and as the colony extended and the population occupied areas of unexplored country, he had to widen the range of his inquiry in order to supply the necessary information to intending settlers. The long series of observations that he published on climate factors, especially those having reference to rain, evaporation, and state of the rivers, attest to his industry, his powers of organization, and his recognition of the requirements of a young and rising colony. He put it on record that when he assumed office there were but five rain-gauges in the colony. On his retirement there were something like two thousand. His discussion of the results has scarcely been as happy as his collection. He seems to have relied upon statistical methods rather than on physical facts, and in this way was led to suggest a theory which would make the amount of precipitation depend upon the moon's nodes. These cycles are shown very distinctly over the few years that he was able to bring under discussion, but his explanation has not been generally accepted. This is a small matter in comparison with the value of the information which he was able to furnish, and which has contributed in no small degree to the prosperity of the colony. This collection of observations will be of the greatest service in subsequent inquiries.

Mr. Russell has left a character for industry and closeness of application that can not but prove stimulating to future astronomers in the southern hemisphere. He was much esteemed by many friends in this country, who regretted his retirement from the observatory; and besides being a Fellow of the Royal Society, to which he was elected in 1886, he was a member of many learned bodies, and was well known as a contributor of frequent and welcome papers.

[1] Part of an obituary notice signed "W. E. P.", printed in Nature (of London), issue of March 7, 1907. Mr. Russell was a member of the International Meteorological Committee. His death occurred at Sydney, Australia, February 22, 1907.—EDITOR.

AN IMPORTANT METHOD IN AERIAL RESEARCH.

As many individuals in this country wish to do something in connection with the recent development of the study of the free air, the Editor takes pleasure in commending to their attention the following translation of an article by Doctor de Quervain, the enthusiastic assistant to Professor Hergesell as secretary of the International Union for Aerial Research. De Quervain's success in Europe in keeping sight of a small balloon (with the help of a special telescope) demonstrates that still better work can be done in the clear air of our prairies and mountain plateaus, where especially we need to know more about the upper currents, and where de Quervain's methods are the least expensive and troublesome of all as yet devised.

In this connection it is worth noting that the need of a better knowledge of the upper currents, the altitudes of clouds, etc., led the Editor to urge the use of pilot balloons in 1871, but an adverse report hindered the work. In 1872 he fitted out the *Florence* arctic expedition with the necessary instructions, including the method for determination of the vertical velocity at each ascension, but it afterwards appeared that the hydrogen gas apparatus was left on shore at New London. In 1889 he carried a large supply of balloons on the cruise of the *Pensacola* round the Atlantic, but the carboy of sulfuric acid frequently made trouble on the deck of the vessel and was soon thrown overboard, so that the work had to stop. (An order to send the carboy "below" was interpreted by the crew to mean "Davy Jones's locker"!)

There are many difficulties in store for us, but we must do the best to overcome them, and make every possible effort to use balloons and kites in the study of the atmosphere. A convenient apparatus for filling small balloons with hydrogen can be bought of the dealers in New York, N. Y., and many chemical laboratories have something equivalent. We hope to hear of these being used for meteorological work.—*C. A.*

A PROPOSAL THAT PILOT BALLOONS BE MORE GENERALLY USED IN MAKING METEOROLOGICAL OBSERVATIONS.

By Dr. A. de QUERVAIN. Translated from Das Wetter, May, 1906, by Dr. C. Abbe, jr.

In investigating the free air it is just as important to have a knowledge of the direction and velocity of the air currents at different levels as it is to know the distribution of temperature. In many cases accurate cloud observations yield us fairly accurate information concerning the directions of these currents. Such observations are yet more valuable if the observatory is also in a position to measure the altitudes of the clouds.

On fine clear days the atmospheric currents even at great altitudes may be studied most advantageously by determining trigonometrically the course of a sounding balloon with the aid of some appropriate instrument. Such a series of observations presented so many practical difficulties, especially in the case of Assmann's rubber baloons, which are now generally used, that until recently no one had undertaken them. Since the accurate study of atmospheric currents has long seemed to me to be of the greatest importance, I have, during the past five years, made numerous practical attempts to work out a method for doing this. Finally, with the support of the firm of J. and A. Bosch, of Strassburg, I succeeded in constructing a special theodolite[1] by the aid of which I found it possible on clear days to determine the path of a sounding balloon with certainty and convenience up to altitudes of over 16,000 meters, and to horizontal distances of over 60 kilo-

[1] See the detailed description in Zeits. Inst'kunde, 1905, p. 135; and Met. Zeit., 1906, p. 149.

meters. Thus it was that in my first trial of the new instrument, while following in the usual way a sounding balloon of the Strassburg Meteorological Institute, I was able for the first time to show that there is a change in the direction of the air currents at the level of the well-known inversion layer at 12,000 meters.[2] I had already, with an experimental model at an earlier date, succeeded in showing that a balloon followed a peculiar looped path at this same level,[3] a conclusion that has since received interesting confirmation in the observations made by Dr. A. Wegener, with one of my instruments, at the Lindenberg Aeronautical Observatory.[4]

Since this new method of observing has yielded the best results from the very beginning, both in these and other cases, there is no doubt but that in the future this determination of the balloon's path will everywhere form a part of the regular program during the ascension of sounding balloons. I would here make special mention of the plan proposed by Professor Assmann, that there be a month of daily ascents of sounding balloons during the Milan Exposition, and that, as far as possible, the courses of all the balloons be determined by this instrument. The most interesting revelations concerning the atmospheric circulation above that region [northern Italy] are to be expected from the carrying out of such a plan.

It is evident that such numerous flights of sounding balloons can be made only where unusual means are at hand. It is possible, however, to secure an important portion of the results, viz, a knowledge of the motions of the atmosphere, at a much smaller cost simply by using pilot balloons. As soon as my theodolite was completed I began trials to determine the distance and the height to which the ordinary child's toy balloon of different sizes could be followed. The favorable results then obtained led to further trials[5] with somewhat larger balloons, at the Meteorological Institute in Strassburg, and in Zürich. These experiments showed that, under favorable circumstances, balloons smaller than the usual sounding balloon and costing only 4 or 5 marks, can be followed to altitudes of more than 8000 meters, while in clear weather it is always possible to follow them to about 5000 meters. If slightly larger balloons were used no doubt the atmospheric currents could be studied up to altitudes of about 10,000 meters. I believe that there is a field here for very valuable observations at those institutions which have but modest means at their command. By observations of such pilot balloons the movements of the atmosphere may be accurately determined to great heights on many and indeed on most days of the year, at relatively small cost and labor. * * * The accuracy of these determinations depends, first of all, upon an accurate knowledge of the balloon's ascensional velocity, and this may be reliably determined to within 5 per cent in individual cases. The degree of accuracy of the resulting horizontal velocity will be in a similar ratio. Cne can see that the attainable accuracy is quite sufficient for the purpose and wholly so for present needs. An accurate comparison of the ascents of sounding balloons at Strassburg shows that they maintain a very uniform vertical velocity, and Professor Hergesell has shown that such is also the theoretical expectation.

It is not at all necessary that the heavens be perfectly clear during the ascension of a pilot balloon. If the clouds are not too low down one may rest satisfied with determining the air-currents up to the cloud level. The altitude of the clouds may be pretty accurately deduced from the time at which the balloon disappears in them; and this, together with the determination of the relative velocity of the clouds, gives accurately the actual velocity of the cloud layer. In the numerous cases where the sky is covered with alto-cumulus or alto-stratus the balloon will have already attained a considerable height before it reaches the cloud. Even on days when the sky is almost completely covered with low-lying clouds, it is very often possible to seize a half hour when at least the lower layers break up for awhile and permit a successful pilot-balloon flight to be made.

In order to gain even an approximate idea as to how many days in the year might be appropriate for such experiments I have compiled for Zurich, Strassburg, Berlin and Milan, the frequencies for two years of such days as showed five-tenths or less cloudiness at at least one of the three observation hours. For Milan I took from the decade-summaries the days having "cielo sereno" and "mista senza precipitazione", which probably gave comparable but too small values. It may be assumed that on such days there may always be found a still more favorable moment for the attempt than at these special hours of observation. The numbers of such favorable days were:

Milan	214
Zurich	209
Strassburg	218
Berlin	213

These numbers should be considered rather as minimum values. On the other hand many difficulties may occur which are independent of the weather. Hence, in calculating the cost of a station which is to take advantage of all favorable conditions, one may count on about 200 observations per year.

Suppose, further, that balloons be used which cost five marks apiece and have an ascensional force of 150 to 250 grams, their ascensional velocity being 4 to 5 meters per second, these permit of being readily followed to altitudes of 4,000 or 5,000 meters and higher. On days when the clouds hang lower, smaller balloons, costing four marks, would be used; and in perfectly clear weather somewhat larger ones, which can possibly be followed to altitudes of 10,000 meters. We shall not here consider those cases where specially large balloons would be risked in order to send them above the the level of the upper inversion stratum and the cirrus clouds. The annual cost, under ordinary conditions, would thus amount to about a thousand marks ($250) for the pilot balloons, and 50 to 100 marks, according to circumstances, for producing the hydrogen gas. Further, each ascent would occupy two persons for about one hour, and in addition one or two hours would be required for the (immediate) working up and plotting of the balloon's path. In regard to this latter point it may be remarked that frequent practise in such observations would lead to many simplifications, e. g., the proper foresight in preparation and in the making of the observations. Simple trials would enable one to determine, once for all, what ascensional force produced a given ascending velocity, e. g., 5 meters per second. It would be an easy matter to devise some filling device which would almost automatically close the balloon as soon as it had acquired the desired lifting power, thereby avoiding the necessity of repeatedly testing and trying before getting the right amount. Again, in observing the flight of the balloon one would have to form the habit of making readings, not at irregular times, but rather at every whole minute, for example. In this way certain even levels for the calculations would be fixt in advance, and by using appropriate summary tabulations of the proper goniometric functions (to three decimal places and to tenths of a degree) the calculations could be performed systematically and rapidly, sometimes even during the flight itself. The proper course will be to plot the locations of the nadir of the balloon graphically in rectangular coordinates, and take the course and velocity from this horizontal projection. Perhaps it would be still simpler to avoid all calculations by adopting a procedure similar to that followed at Blue Hill during the year of international cloud observations. In this method one

[2] See Beiträge zur Physik der freien Atmosphäre, Bd. 1, p. 143.

[3] Ibid., p. 47. [4] Ibid., bd. 2, heft 1.

[5] It should be recalled that von Sigsfeld and Professor Kremser both put this idea into execution thirteen years ago, using paper balloons.

simply places a very small theodolite provided with an index arm, reading to 1/10 degree, directly over the origin of the coordinates on the drawing paper, and sights upon a divided rule supported vertically. Better still would it be to set the small theodolite at the reading, for any moment, of the large instrument with which the balloon is observed, and then bring the mark on the divided rule corresponding to the altitude at that moment, into the line of sight of the theodolite. The sharp point marking the location of the foot of the rule would then indicate the position of the vertical projection of the balloon or its nadir. There is no doubt that, with a little practise, the path of the balloon could be graphically plotted in a few minutes by this method. However there would be a certain amount of difficulty when the angular altitude became very great, and in general for the first few points of every path traced. Whichever method be selected, the observer will have to accustom himself to carrying out the measurements in a definite routine and an intelligible way. I foresee the time when the watchman of many a meteorological observatory will perform these duties in the same apathetic way in which he now goes about the routine of the periodic observations which today constitute the observational portion of the observatory duties.

At first, to be sure, one will regard the reduction of each new observation as a *novum atque inauditum,* as regards its results. Yet even if such regular observations and measurements are inaugurated at only a single station, the expense and trouble entailed would be richly repaid, especially at localities having fine weather, by the incomparably more accurate knowledge thus gained, as compared with our present knowledge concerning changes in the direction and velocity of the wind with increasing altitude. What splendid support such a series of measurements would afford to works like the admirable investigations into the circulation of the atmosphere by H. Hildebrandsson[6]. How much more excellent support would be furnished if we had simultaneous observations from a number of stations. Many, and perhaps those precisely who have the progress of meteorology most at heart, will be somewhat skeptically inclined toward a proposal for new simultaneous international observations. Ever new demands, and where is the fulfilment of earlier promises?

In reply, it must first of all be emphasized that the present case does not seem to call for any special prearrangement or international preparation beyond an occasional arrangement among those actively interested so that the results may be published as soon as possible. It is superfluous to make any special agreement as to dates for the flight trials, since the observations are to be made on every day that is in any degree favorable for them, and hence they are necessarily as simultaneous as it is possible for them to be.

To those whose past experience induces a certain hesitancy toward these new proposals I would present the following considerations. In the case of the international simultaneous observations in the free air as thus far carried out, with which one mentally connects my present proposition, we are dealing with measurements which demand extraordinary care if the quantities that it is intended to measure are to be truly comparable. This can not be secured thru the improvement of the instruments alone. The sources of error are so numerous and so great that unless each and every point is taken account of in the handling of the instruments and the calculation of the results, the resulting uncertainties will exceed the very differences which it is desired to determine. Unfortunately, it has also been found that the requisite many-sided painstaking qualities and the delicate sense of the physicist are not possest by every one, and cannot be purchased with the instrument from the manufacturer. If then, and chiefly for these reasons, the above-mentioned international arrangements have not yet met with the unqualified success which was once expected of them, and if the more accurate discussion of their results has been so far delayed precisely because they are believed to be not perfectly comparable—still similar doubts should not be transferred to the simpler simultaneous observations which I here propose. To be sure, even these observations demand a certain degree of care, as do all that are to be of any value at all. But the sources of error are much more limited and the possible errors are of much smaller magnitude as compared with the quantities to be measured. The procedure is indeed a right simple one: determine the buoyancy or ascensional force of a balloon, sight the telescope, read a clock and a coarsely divided circle; all these manipulations demand only a fairly delicate physical sense (the light touch and sharp eye of a good observer); and if they are carried out by a man who is at all conscientious in his work can not well fail to be sufficiently well executed. One is therefore justified in assuming that, in general, we shall not have to deal with results which may be accepted "only with great caution".

The measurements under discussion possess the further advantage that the results can be deduced and applied immediately after the experiment, an advantage so much emphasized as attaching also to the otherwise very troublesome kite flights. Without indulging in unfounded hopes I seriously expect to find such pilot-balloon observations of some value in weather forecasting. It is true that the evidence for this is as yet lacking, because I have no materials on which to base the statement. General considerations, however, make it quite clear that precisely at the times of change from fair weather to rain, which are the special difficulties of the forecaster, there must occur changes in the upper circulation whose significance would thereby be learned. To all earnest, experienced forecasters, to all those who do not approach their predictions in the spirit of Kepler when casting horoscopes, but who would endeavor to attain the attainable, I would put this question: "Do you believe that in the presence of that sudden, recent change of weather the accurate knowledge of the wind's direction and velocity at levels of 5000 to 10,000 meters would have aided you in forecasting"? If the answer is "yes", then I would say that in the future this knowledge may be cheaply and readily secured. If the answer be "no", than I would ask: "What attainable data would be of help?"

For the present it is to be urgently recommended to all institutions and private students who are in any wise able to carry them out, that they inaugurate continuous and regular observations of pilot-balloon flights. The results will soon prove to have a purely scientific value and probably will also be of importance in forecasting.

[6] I refer particularly to the second part of his "Rapport sur les observations internationales de nuages", Upsala, 1905.

HERMAN DECLERCQ STEARNS.

By G. A. CLARK, Secretary Leland Stanford Junior University, Palo Alto, Cal. Dated November 15, 1907.

Herman Declercq Stearns, associate professor of physics in Leland Stanford Junior University, died of tuberculosis on October 21, after an illness of four years. Professor Stearns was born in Joliet, Ill., September 14, 1865. His preparatory education was gained in the public schools of Joliet. After graduating from the high school he became a teacher, and taught for some time in the Joliet High School, later becoming principal of the public school at Lake Forest, Ill. He entered Lake Forest University with the class of 1892, but left in 1891 to enter Stanford University, which opened that year. He took his A. B. degree at Stanford in 1892, and his A. M. degree in 1893. He was made instructor in physics in the university in 1893, assistant professor in 1896 and associate professor in 1900. He was a student in the University of Berlin during the academic year 1897–98, where he gave most of his time to the study of meteorology under von Bezold.